CLAIMS

1. A measurement method for a bead cutting shape of an electric resistance welded pipe, for measuring the shape following cutting a bead generated on the inner face or outer face of an electric resistance welded pipe at a welding portion, said method comprising:

a step for obtaining an optical cutting image, by taking an image of slit light irradiated on said bead portion with image-taking means, from an angle different to the irradiation direction of said slit light;

a step for obtaining each of

maximum luminance in the pipe axial direction at a given width-direction coordinate on said optical cutting image, and

maximum luminance in background texture region outside of the irradiation range of said slit light;

a step for performing interior division of the maximum luminance of said pipe axial direction and the maximum luminance of said background texture region by a ratio determined beforehand, and setting the obtained

luminance as a threshold value;

a step for taking a luminance greater than said threshold value and a weighted mean of pipe axial direction coordinates indicating said luminance as pseudo-cross-sectional direction coordinates for said width-direction coordinates and pipe axial direction coordinates; and

a step for calculating the bead cutting shape of said electric resistance welded pipe based on

a pseudo-cross-sectional shape obtained by stringing pseudo-cross-sectional direction coordinates in the width direction, and

a predetermined conversion expression determined from a geometric positional relation of

said light source of said slit light,

said image-taking means, and

said electric resistance welded pipe.

2. A measurement method for a bead cutting shape of an electric resistance welded pipe, for measuring the shape following cutting a bead generated on the inner face

or outer face of an electric resistance welded pipe at a welding portion, said method comprising:

a step for obtaining an optical cutting image, by taking an image of slit light irradiated on said bead portion with image-taking means, from an angle different to the irradiation direction of said slit light;

a step for taking, in the event that the maximum luminance in the pipe axial direction at a given width-direction coordinate on said optical cutting image is equal to or exceeds a predetermined fixed threshold value, a weighted mean of pipe axial direction coordinates indicating said luminance as pseudo-cross-sectional direction coordinates for said width-direction coordinate and pipe axial direction coordinate;

a step for obtaining, in the event that the maximum luminance is less than the predetermined fixed threshold value, each of

maximum luminance in the pipe axial direction at a given width-direction coordinate on said optical cutting image, and

maximum luminance in background texture region

outside of the irradiation range of said slit light;

a step for performing interior division of the maximum luminance of said pipe axial direction and the maximum luminance of said background texture region by a ratio determined beforehand, and setting the obtained luminance as a threshold value;

a step for taking a luminance greater than said threshold value and a weighted mean of pipe axial direction coordinates indicating said luminance as pseudo-cross-sectional direction coordinates for said width-direction coordinates and pipe axial direction coordinates; and

a step for calculating the bead cutting shape of said electric resistance welded pipe based on

a pseudo-cross-sectional shape obtained by stringing pseudo-cross-sectional direction coordinates in the width direction, and

a predetermined conversion expression determined from a geometric positional relation of

said light source of said slit light,

said image-taking means, and

said electric resistance welded pipe.

3. A measurement device for a bead cutting shape of an electric resistance welded pipe, said device comprising:

a slit light source for irradiating slit light at a given incident angle on a bead portion of an electric resistance welded pipe following cutting;

image-taking means for taking an irradiation image of said slit light at a different receiving angle;

a first computation circuit for calculating, with regard to the optical cutting image output from said image-taking means,

the maximum luminance in the pipe axial direction at a given width-direction coordinate on said optical cutting image, and

the pipe axial direction coordinate where said maximum luminance occurs;

a second computation circuit for calculating the maximum luminance in background texture region, at a position removed by a predetermined number of pixels or

more from a pipe axial direction coordinate where said maximum luminance in said pipe axial direction occurs at a given width-direction coordinate;

an accumulation circuit for calculating

a luminance which is greater than a threshold calculated following a predetermined computation expression from said first computation circuit and said second output computation circuit, and

the weighted mean of pipe axial direction coordinates indicating said luminance;

an image reconfiguring circuit for stringing the weighted mean of pipe axial direction coordinates thus calculated to generate a pseudo-cross-sectional shape in the width direction; and

a coordinates computation circuit for calculating and displaying the bead cutting shape of said electric resistance welded pipe based on a predetermined conversion expression determined from a geometric positional relation of

said slit light source,

said image-taking means, and

said electric resistance welded pipe.

4. A measurement device for a bead cutting shape of an electric resistance welded pipe, said device comprising:

a slit light source for irradiating slit light at a given incident angle on a bead portion of an electric resistance welded pipe following cutting;

image-taking means for taking an irradiation image of said slit light at a different receiving angle;

a first computation circuit for calculating, with regard to the optical cutting image output from said image-taking means,

the maximum luminance in the pipe axial direction at a given width-direction coordinate on said optical cutting image, and

the pipe axial direction coordinate where said maximum luminance occurs;

a branch circuit for judging whether or not the maximum luminance in the pipe axial direction at said certain width direction is equal to or greater than a

predetermined fixed threshold value;

a second computation circuit for calculating the maximum luminance in background texture region, at a position removed by a predetermined number of pixels or more from a pipe axial direction coordinate where said maximum luminance in said pipe axial direction occurs at a given width-direction coordinate;

a first accumulation circuit for calculating the weighted mean of pipe axial direction coordinates greater than a threshold obtained by interior division of

the maximum luminance in the pipe axial direction at said certain width direction, and

the maximum luminance at background texture region,

by a predetermined ratio;

a second accumulation circuit for calculating said luminance equal to or greater than said predetermined fixed threshold value and the weighted mean of pipe axial direction coordinates indicating said luminance;

an image reconfiguring circuit for selecting the output of said first accumulation circuit and said second

accumulation circuit thus calculated following output from said branch circuit and stringing said output in the width direction so as to generate a pseudo-cross-sectional shape; and

a coordinates computation circuit for calculating and displaying the bead cutting shape of said electric resistance welded pipe based on a predetermined conversion expression determined from a geometric positional relation of

said slit light source,

said image-taking means, and

said electric resistance welded pipe.

5. A measurement method for a bead cutting shape of an electric resistance welded pipe, for calculating the bead shape of an electric resistance welded pipe by subjecting to predetermined image processing an optical cutting image obtained by taking an image of slit light irradiated on a bead generated on the inner face or outer face of an electric resistance welded pipe at a welding portion, with image-taking means, from an angle different

to the irradiation direction of said slit light;

wherein an image obtained by overlaying

said optical cutting image and

an optical cutting image following thinning processing of said optical cutting image by predetermined processing means

is displayed.

6. A measurement method for a bead cutting shape of an electric resistance welded pipe according to Claim 5, wherein the color of each pixel in said optical cutting image following thinning is colored with a color corresponding to an SN ratio determined by a ratio between the luminance of the optical cutting image on an optical cutting image corresponding to said pixel, and the maximum luminance in a region outside of said slit light and is displayed.

7. A measurement method for a bead cutting shape of an electric resistance welded pipe according to Claim 5, wherein the color of each pixel in said optical cutting

image following thinning by predetermined image processing means of an optical cutting image obtained by taking an image of irradiated slit light with image-taking means from an angle different to the irradiation direction of said slit light, is categorized and colored with a color corresponding to an SN ratio determined by a ratio between the luminance of the optical cutting image on the optical cutting image corresponding to said pixel, and the maximum luminance in a region outside of said slit light, and is overlaid with said optical cutting image and displayed.

8. A measurement device for a bead cutting shape of an electric resistance welded pipe, said device comprising:

a slit light source for irradiating slit light at a given incident angle on a bead portion of an electric resistance welded pipe following cutting;

image-taking means for taking an irradiation image of said slit light at a different receiving angle;

a thinning processing circuit for processing said optical cutting image output from said image-taking means

so as to display the image of said slit light with one pixel; and

an image synthesizing circuit for overlaying said optical cutting image, and the results of said thinning, on the same image.

9. A measurement device for a bead cutting shape of an electric resistance welded pipe, said device comprising:

a slit light source for irradiating slit light at a given incident angle on a bead portion of an electric resistance welded pipe following cutting;

image-taking means for taking an irradiation image of said slit light at a different receiving angle;

a thinning processing circuit for processing said optical cutting image output from said image-taking means so as to display the image of said slit light with one pixel; and

a thinning circuit for coloring the color of each pixel in said thinned optical cutting line corresponding to an SN ratio determined by a ratio between the luminance

of the slit light image on the optical cutting image corresponding to said pixel, and the maximum luminance in a region outside of said slit light.

10. A measurement device for a bead cutting shape of an electric resistance welded pipe according to Claim 9, further comprising an image synthesizing circuit for overlaying said optical cutting image, and the colored results of said thinning output by said thinning circuit, on the same image.

11. An electric resistance welded pipe bead shape detecting method, for detecting the bead shape of an electric resistance welded pipe by the optical cutting method, wherein an image, obtained by a slit light being irradiated or a point light being scanned on a welding portion of an electric resistance welded pipe and an image of the slit light irradiated on the surface of the welding portion or an image of the track of the point light scanned thereupon being taken with image-taking means from an angle different to the irradiation direction of said

slit light, is subjected to predetermined image processing; said method comprising:

a step for calculating coordinates for a temporary bead apex by a predetermined calculation expression from a profile of an electric resistance welded pipe;

a step for obtaining a first approximation curve by approximating said profile of said electric resistance welded pipe with a quadratic function;

a step for calculating the coordinates for two intersecting points on either side of said temporary bead apex from said profile of said electric resistance welded pipe and said first approximation curve;

a step for calculating a temporary existence range of the bead by a predetermined calculation expression from

the coordinates of said temporary bead apex, and

the coordinates of two intersection points on either side of said temporary bead apex;

a step for obtaining a second approximation curve by approximating a base pipe shape excluding the temporary existence range of said bead from said profile of said electric resistance welded pipe with an polynomial

expression of a degree which is even and quadratic or higher; and

a step for determining, of regions wherein the deviation between said profile of said electric resistance welded pipe and said second approximation curve is greater than a predetermined threshold value, a region containing the coordinates of said temporary bead apex as being the bead.

12. An electric resistance welded pipe bead shape detecting device, comprising:

light projecting means for irradiating a slit light or scanning a point light on a welding portion of an electric resistance welded pipe at a given angle;

image-taking means for taking an image of said projected light irradiated on the welding portion by said light projecting means, from an angle different to said given angle;

profile calculating means for calculating a profile of said electric resistance welded pipe by subjecting the image obtained from said image-taking means to

predetermined image processing;

temporary bead apex detecting means for calculating coordinates for a temporary bead apex by a predetermined calculation expression from the profile of said electric resistance welded pipe;

first regression computation means for approximating with a predetermined regression expression, with said profile of said electric resistance welded pipe as a quadratic function;

intersecting point calculating means for calculating the coordinates for two intersecting points on either side of said temporary bead apex from the output of said first regression computation means and the output of said profile calculating means;

first range calculating means for calculating a temporary existence range of the bead by a predetermined calculation expression from the coordinates of said intersection points and the coordinates of said temporary bead apex;

second regression computation means for approximating said profile of said electric resistance welded pipe

excluding the temporary existence range of the bead thus calculated, with an polynomial expression of a degree which is even and quadratic or higher; and

second range calculating means for outputting, of regions wherein the deviation between output from said second egression computation means is greater than a predetermined threshold value and said profile of said electric resistance welded pipe, a region containing the coordinates of said temporary bead apex as being the bead range.

13. An electric resistance welded pipe bead shape detecting method, for detecting the bead shape of an electric resistance welded pipe, wherein an image, obtained by a slit light being irradiated or a point light being scanned on a pipe surface including a bead portion due to welding of an electric resistance welded pipe, and an image of the slit light irradiated on the pipe surface including the bead portion or an image of the track of the point light scanned thereupon being taken with image-taking means from an angle different to the irradiation

direction of slit light, is subjected to predetermined image processing; said method comprising:

a step for obtaining shape data of a portion of the pipe surface equivalent to the bead portion from shape data of the pipe surface including the bead portion calculated in said image processing, from preset boundaries at the left and right edges of the bead portion, and an apex position of the bead portion calculated separately;

a step for dividing said shape data of the portion of the pipe surface equivalent to said bead portion into two regions, left and right;

a step for performing approximation with a function with regard to each of the left and right shape data, so as to obtain approximation functions for the left and right bead shapes;

a step for performing further approximation with a function, with regard to base pipe shape data excluding the pipe surface shape data of the portion equivalent to said bead portion from the shape data of the pipe surface including the bead portion, so as to obtain base pipe

shape approximation functions; and

a step for calculating at least one of the width, height, slope angle, and step at the left and right boundaries between the bead portion and base pipe, based on each of said left and right bead shape approximation functions, and said base pipe shape approximation function.

14. An electric resistance welded pipe bead shape detecting method according to Claim 13, wherein calculations are performed to minimize the error between said left and right bead shape approximation functions and the shape data of the pipe surface including said bead portion, with approximation functions for said left and right bead shapes as functions wherein two or more straight lines with different inclinations are linked, and with the position of the linking points, the inclination of the straight lines, and intercept, as parameters.

15. An electric resistance welded pipe bead shape detecting method according to either Claim 13 or 14,

wherein said intersecting points between

said left and right bead shape approximation functions and

said base pipe shape approximation function

are calculated as the boundaries of both edges of the bead portion;

and wherein at least one of the bead width, height, slope angle, and step at the left and right boundaries between the bead portion and base pipe, is calculated, based thereupon.

16. An electric resistance welded pipe welding bead height detecting method according to any one of Claims 13 through 15, wherein the difference in said bead shape approximation function values and said base pipe shape approximation function values at the electric resistance welded pipe cross-sectional direction position on the apex of said bead portion is calculated as the bead height.

17. An electric resistance welded pipe welding bead slope angle detecting method according to any one of

Claims 13 through 15, wherein said intersecting points between said left and right bead shape approximation functions and said base pipe shape approximation function are calculated as the boundaries of both edges of the bead portion, respective differential coefficients are calculated for the intersecting points between said left and right bead shape approximation functions and said base pipe shape approximation function at the electric resistance welded pipe cross-sectional direction position, and the left and right bead slope angles are each calculated, based thereupon.

18. An electric resistance welded pipe bead shape detecting device, comprising:

light projecting means for irradiating a slit light or scanning a point light on a pipe surface including a welding portion of an electric resistance welded pipe;

image-taking means for taking an image of said projected light irradiated on said pipe surface including said welding portion, from an angle different to that of said light projecting means;

bead shape calculating means for calculating the bead shape of said electric resistance welded pipe by subjecting the image obtained from said image-taking means to predetermined image processing;

an apex position setting circuit and a bead range setting circuit, for calculating the bead apex position and each of the boundary positions between the bead portion and the base pipe excluding the bead portion, based on the bead shape data calculated by said bead shape calculating means;

a bead shape approximation circuit for calculating approximation functions for the left and right bead shapes, based on

the apex position output from said apex position setting circuit and bead range setting circuit and

the left and right boundary positions on either side of the bead apex position;

a base pipe shape approximation circuit for calculating a base pipe shape approximation function, based on base pipe shape data further outwards from the left and right boundary positions which said bead range

setting circuit outputs;

a bead range re-setting circuit for re-setting the intersections between

the left and right bead shape approximation functions output by said bead shape approximation circuit, and

the base pipe shape approximation function output from said base pipe shape approximation circuit

as left and right boundary positions; and

a features calculating circuit for calculating at least one of the bead width, height, slope angle, and step at the left and right boundaries between the bead portion and base pipe, based on the output of each of said bead range setting circuit, bead shape approximation circuit, and base pipe shape approximation circuit.